

# Constellation Program:

## America's Fleet of Next-Generation Launch Vehicles

### The Ares V Cargo Launch Vehicle

Planning and early design are under way for hardware, propulsion systems and associated technologies for NASA's Ares V cargo launch vehicle — the "heavy lifter" of America's next-generation space fleet.

Ares V will serve as NASA's primary vessel for safe, reliable delivery of large-scale hardware to space — from the lunar landing craft and materials for establishing a moon base, to food, fresh water and other staples needed to extend a human presence beyond Earth orbit.

Under the goals of NASA's exploration mission, Ares V is a vital part of the cost-effective space transportation infrastructure being developed by NASA's Constellation Program to carry

human explorers back to the moon, and then onward to Mars and other destinations in the solar system.

The Ares V effort includes multiple hardware and propulsion element teams at NASA centers and contractor organizations around the nation, and is led by the Exploration Launch Projects Office at NASA's Marshall Space Flight Center in Huntsville, Ala. These teams rely on nearly a half century of NASA spaceflight experience and aerospace technology advances. Together, they are developing new vehicle hardware and flight systems and maturing technologies evolved from powerful, proven Saturn rocket and space shuttle propulsion elements and knowledge.



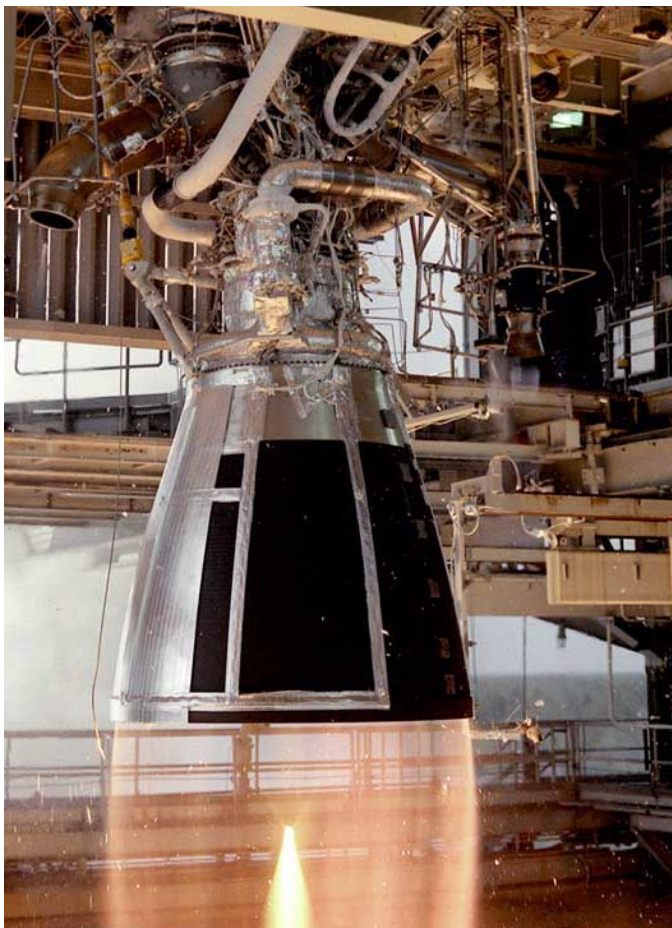
Concept image of Ares V in Earth orbit. (NASA/MSFC)

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The versatile, heavy-lifting Ares V is a two-stage, vertically stacked launch system. The launch vehicle can carry about 290,000 pounds (131,800 metric tons) to low-Earth orbit and 144,000 pounds (65 metric tons) to lunar orbit.

For its initial insertion into Earth orbit, the first stage relies on two five-segment reusable solid rocket boosters. These are derived from the space shuttle solid rocket boosters and are similar to the single booster that serves as the first stage for the cargo vehicle's sister craft, the Ares I crew launch vehicle. This hardware commonality makes operations more cost effective by using the same manufacturing facilities for both the crew and cargo vehicles.

The twin reusable solid rocket boosters of the cargo lifter's first stage flank a single, liquid-fueled central booster element, known as the core stage. Derived from the Saturn V, the core stage tank delivers liquid oxygen/liquid hydrogen fuel to a cluster of five RS-68 rocket engines. The engines are upgraded versions of those currently used in the Delta IV, the largest of the Delta rocket family developed in the 1990s by the U.S. Air Force for its Evolved Expendable Launch Vehicle program and commercial launch applications. Together, these propulsion elements comprise the Ares V's first stage.



An RS-68 engine undergoes hot-fire testing at NASA's Stennis Space Center near Bay St. Louis, Miss., during the engine's developmental phase. (Pratt & Whitney Rocketdyne)



Concept image of Ares V elements. (NASA/MSFC)

Atop the central booster element is an interstage cylinder, which includes booster separation motors and a newly designed forward adapter that mates the first stage with the second, or Earth departure stage. This unique upper stage, being designed at Marshall, is propelled by a J-2X main engine fueled with liquid oxygen and liquid hydrogen. The J-2X is an evolved variation of two historic predecessors: the powerful J-2 upper-stage engine that propelled the Apollo-era Saturn 1B and Saturn V rockets to the moon and the J-2S, a simplified version of the J-2 developed and tested in the early 1970s.



**Concept image of the J-2X engine. (NASA/MSFC)**

Anchored atop the Earth departure stage is a composite shroud protecting the lunar surface access module, which includes the descent stage that will carry explorers to the moon's surface and the ascent stage that will return them to lunar orbit to rendezvous with the Orion crew exploration vehicle for their return home.

During launch of an Ares V, the reusable solid rocket boosters and core propulsion stage power the vehicle into low-Earth orbit. After separation from the spent core stage, the Earth departure stage's J-2X engine takes over, placing the vehicle in a circular orbit. The Orion spacecraft carrying four astronauts is delivered to space separately by the Ares I launch vehicle. Orion then docks with the orbiting departure stage and its lunar lander payload. Once mated, the Earth departure stage fires its J-2X engine a second time to achieve "escape velocity," the speed necessary to break free of Earth's gravity, and the lunar vessel begins its journey to the moon.

The Earth departure stage is jettisoned after it puts the mated Orion spacecraft and lunar module on course for the moon. Once the astronauts arrive in lunar orbit, they transfer to the lunar module and descend to the moon's surface. Orion remains in orbit until the astronauts depart from the moon in the lunar vessel, rendezvous with the spacecraft in orbit and return to Earth.

The cargo vehicle's rockets can lift heavy payloads, such as equipment and hardware, to Earth orbit or trans-lunar injection, a trajectory designed to intersect with the moon. Such lift capabilities will enable NASA to carry a variety of science and exploration payloads to space and, in time, undertake crewed missions to Mars and beyond.

The first test flight of the Ares V is planned for around 2018. The first crewed lunar excursion is scheduled for launch in the 2020 timeframe.

The Ares V effort and associated element hardware and propulsion teams are led by the Exploration Launch Projects Office at Marshall, which reports to the Constellation Program Office at NASA's Johnson Space Center in Houston. Constellation is a key program of NASA's Exploration Systems Mission Directorate in Washington.

ATK Launch Systems of Brigham City, Utah, is the prime contractor for the reusable solid rocket boosters. Pratt & Whitney Rocketdyne of Canoga Park, Calif., is the prime contractor for both the J-2X upper stage engine and the RS-68 core stage engines.





**Concept image of the Ares V earth departure stage in orbit, shown with the Orion docked with the Lunar Surface Access Module. (NASA/MSFC)**

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